The Effect of Ultrasound Therapy and Upper Cervical Manipulative Therapy as well as the Combination thereof on Chronic Sinusitis

ABSTRACT

Purpose: The purpose of this study was to establish the effect of ultrasound therapy and upper cervical manipulative therapy as well as the combination thereof on chronic sinusitis.

Method: Thirty participants who suffered from chronic sinusitis as indicated by the Sino-Nasal Outcome Test, participated in this study. Participants were randomly allocated into three equal groups. Group 1 received upper cervical manipulative therapy. Group 2 received ultrasound therapy on the frontal and maxillary sinuses and Group 3 received a combination of ultrasound therapy on the frontal and maxillary sinuses as well as upper cervical manipulative therapy. The study consisted of seven consultations over a three week period, with intervention on the first six consultations and subjective as well as objective data obtained occurred at the first, fourth and seventh consultations. The intervention period for Group 1 consisted of motion palpation of any restriction in the upper cervical spine. Diversified chiropractic techniques were used by the researcher to manipulate the restricted segment. Group 2 received ultrasound therapy on the frontal and maxillary sinuses and Group 3 received a combination of both cervical manipulative therapy as well as ultrasound therapy on the frontal and maxillary sinuses.

Results: The subjective data had a positive average improvement of **74.9 %** for Group 1, **68.9 %** for Group 2 and **73 %** for Group 3. The objective data had a positive average improvement of **34 %** for Group 1, **21.9 %** for Group 2 and **29.1 %** for Group 3.

Conclusion: This research thus proved that ultrasound therapy and upper cervical manipulative therapy as well as the combination thereof did benefit participants with chronic sinusitis. Participants had to receive all six treatments to experience a significant difference in their signs and symptoms.

This research further proved that no treatment protocol was more beneficial than another for the treatment of chronic sinusitis. Therefore, depending on practitioner's preference of a treatment protocol, all individuals will still benefit from the three treatments tested.

Key Words: Chronic Sinusitis, Ultrasound, Chiropractic, Cervical Manipulative Therapy, Sino-Nasal Outcome Test

INTRODUCTION

Chronic sinusitis has been defined as persistent symptomatic inflammation of the nasal and sinus mucosa resulting from the interaction of multiple host and environmental factors (Kern, 2008). Viral upper respiratory tract infections are highly relevant to chronic sinusitis, which causes the nose and paranasal sinuses to become inflamed and swollen, making it difficult for the sinuses to drain normally (Torpy, 2011).

The average healthy adult person experiences between 1 and 3 common colds per year. According to Hamilos (2014), the onset and time course of cold symptoms and levels of viral messenger ribonucleic acid (mRNA) detectable in nasal secretions over 21 days have been mapped out in healthy adults after experimental rhinovirus infection. A higher peak in onset and duration of symptoms of the rhinovirus has been noted in patients with asthma or chronic obstructive pulmonary disease. Chronic sinusitis can also be caused by bacterial pathogens such as *Haemophilus influenzae, Streptococcus pneumoniae and Moraxella catarrhalis*, as well as other pathogens such as allergy, fungi, superantigen and biofilm (Sanderson, 2006).

Chronic sinusitis is currently treated by physicians using an initial trial therapy, which consists of antibiotics, saline nasal irrigation and topical nasal corticosteroids. However, although antibiotic treatment is effective in acute sinusitis, it has been shown to have an increased resistance and therefore does not always benefit the patient with chronic sinusitis. The sinus drainage and ventilation is enhanced by saline washes, which clear secretions and enhance mucocilliary transport. However, no study has been done on the long term benefits on this treatment. In addition, topical nasal corticosteroids have indicated to relieve sinus symptoms over a short period of time but when used for a prolonged period of time, an increase of resistance occurs. Thus, if the patient's symptoms do not respond to this first-line therapy, oral corticosteroids and decongestants are given as second-line therapy. If the second-line therapy also fails, allergic therapy and environmental control are considered. However, there is no evidence supporting the effects of antihistamine and decongestants on chronic sinusitis (Steele, 2005). Endoscopic sinus surgery will take place as definitive therapy if all the above mentioned treatments fail (Steele, 2005). Endoscopic sinus surgery has offered the highest short-term improvement of all treatment approaches, providing benefit to 75–90% of patients. However, no of these treatments offer proven long-term benefits to patients with chronic sinusitis.

The effect of cervical manipulative therapy on chronic sinusitis

Headache, sinus pain and tenderness develop owing to vertebral restrictions in the upper cervical spine. These restrictions occur because of the state of the trigeminocervical nucleus, which is located in the upper cervical spine. The nucleus is formed by the trigeminal, facial, glossopharyngeal and vagus cranial nerves as well as C1-C3/4 spinal nerves. When the spinal nerves are compressed or irritated owing to a restriction in the upper cervical spine, nociceptive input is sent to the trigeminocervical nucleus and from there to any structure innervated by the nerves forming the trigeminocervical nucleus. When these restrictions are corrected by spinal manipulative therapy, compression and irritation of the nerve roots is reduced, which will relieve symptoms caused by these restrictions (Bogduk, 2001).

Ultrasound therapy

Ultrasound therapy has been used since the early 1940's by health care practitioners. Ultrasound therapy is applied with an ultrasound probe, which is directly in contact with the skin. An ultrasound transmission gel is used between the head of the probe and the patient's skin to reduce friction and to assist in the transmission of the ultrasonic waves, as shown in Figure 1.

Ultrasound waves are generated by a piezoelectric effect. This effect is achieved by the vibration of crystals within the head of the probe. The ultrasonic waves cause a vibration of the local soft tissues as they penetrate through the skin. This vibration causes a deep heat in the local soft tissue and the patient usually does not feel this heat (Miller, 2014).

The effect of ultrasound therapy on chronic sinusitis

In chronic sinusitis, biofilms create an environment for microbial proliferation. This proliferation leads to the formation of a three-dimensional extracellular matrix. Microbial biofilms are highly resistant to antibiotics and other chemical and physical agents. Biofilms and inflammatory cells may also contribute to the damage of the epithelial layer and polyp formation. Ultrasound therapy has been proven to be effective in the treatment of chronic sinusitis by disruption of biofilms and nasal polyps (Karosi, 2013).

A clinical trial on the treatment of chronic rhinosinusitis with continuous ultrasound indicates that one of the major factors that attribute to the failure of medical treatment for chronic sinusitis is poor blood circulation. In this trial, participants showed a significant decrease in symptoms, indicating that patients do benefit from continuous ultrasound therapy (Naghdi, 2008).

In addition, an earlier study done by Ansari (2007), indicates that low intensity pulsed ultrasound therapy also has a significant effect on patient symptoms with chronic sinusitis. In Ansari's study, a randomised, double-blind clinical trial comparing the effect of continuous and pulsed ultrasound in patients with chronic rhinosinusitis indicated that patients benefit in both pulsed and continuous ultrasound therapy (Ansari, 2012).

Another study, done by Rocha (2011), concluded that applying continuous 1-MHz low intensity ultrasound therapy over the maxillary sinuses and nasal septum results in decreased nasal obstruction and improved nasal airflow.

Because ultrasound therapy results in an increased blood flow, it facilitates a pro-inflammatory response as well as acts as pain reliever, and therefore will be effective in aiding breathing (Speed, 2001).

The varies studies that has been done on the effect of ultrasound therapy on chronic sinusitis indicate the efficacy of this treatment, and therefore one can concluded that patients who suffers from chronic sinusitis do benefit from ultrasound therapy.

The Pressure Algometer

The Pressure Algometer is a device that can be used to identify the pressure and/or force eliciting a pressure-pain threshold. Kinser (2009) researched the validity and reliability of the pressure algometer, finding that the device was highly correlated with readings from a force plate and therefore might be considered valid. In this study, readings of the frontal and maxillary sinuses was taken at visits one, four and seven.

MATERIALS AND METHODS

Selection criteria

This was an experimental study using random group allocation. Thirty participants who suffered from chronic sinusitis as confirmed by the Sino-Nasal Outcome Test participated in this study. Participants were randomly allocated into three groups of equal size. The groups received the following treatments:

- Group 1 received upper cervical manipulative therapy.
- Group 2 received ultrasound therapy on the frontal and maxillary sinuses.
- Group 3 received a combination of ultrasound therapy on the frontal and maxillary sinuses as well as upper cervical manipulative therapy.

Methodology

Participants were recruited through advertisements placed in the local newspaper as well as posters that were placed at the University of Johannesburg Day Clinic. Participants had to meet the inclusion criteria to be part of the study. The study took place at the University of Johannesburg Chiropractic Day Clinic. Each participant was treated twice a week over a three week period, which consisted of seven consultations and a total of six treatments.

The initial consultation included:

- Explanation of the study to the participants;
- Reading of an information and consent form and signing of the consent form;
- Completing a case history and full physical examination;
- Completing a cervical regional examination;
- Completing a Sino-Nasal Outcome Test; and
- Measuring the pressure pain threshold of the frontal and maxillary sinuses before the participant received any treatment.

Depending on the group, the participant received either upper cervical manipulative therapy (if the participant was in Group 1), ultrasound therapy (if the participant was in Group 2) or a combination of upper cervical manipulative therapy and ultrasound therapy (if the participant was in Group 3).

The follow-up consultations included:

- Treatment to the participants according to their specific groups at visits two to six;
- Pressure pain threshold measurements of the frontal and maxillary sinuses, taken at visit four and visit seven; and
- Completion of the Sino-Nasal Outcome Test at visit four and visit seven.

Treatment intervension

Group 1 received cervical manipulative therapy of C0 - C4 vertebrae. This therapy entailed motion palpation of any restriction in the upper cervical spine. Diversified chiropractic techniques were used by the researcher to manipulate the restricted segment. Group 2 received ultrasound therapy on the frontal and maxillary sinuses and a Dynatron 850 plus ultrasound unit was used to apply ultrasound therapy on the frontal and maxillary sinuses. The settings that were used in this study were the same as those described by Naghdi (2008). The ultrasound parameters were set to continuous mode, with intensities of 1 Watt per square centimetre (W/cm²) for the maxillary sinuses and 0.5 W/cm² for the frontal sinuses. The frequency was set at 1 Megahertz (MHz). The duration of treatment was five minutes for each maxillary sinus and four minutes for each frontal sinus. Between the ultrasound applicator and the participant skin, a transmission ultrasound gel was used to reduce friction and assist in the transmission of the ultrasonic waves (Naghdi, 2008). Group 3 received a combination of both cervical manipulative therapy as well as ultrasound therapy.

RESULTS

The Shapiro-Wilk Test was applied to the subjective and objective data in all three groups to test for normality. All the p-values were more than 0.05, as shown in Table 4.1 and Table 4.2, therefore the data was normally distributed. Owing to the small sample sizes (n = 10), it was decided with the discretion of the statistician to use non-parametric tests for the analysis of the subjective as well as the objective data collected.

Subjective Data Analysis

Sino-Nasal Outcome Test

The subjective data in this study was gathered from the Sino-Nasal Outcome Test scores as shown in Figure 2. The values in this discussion can be seen in Table 1. When the three groups are compared over the seven visits, it is evident that a positive improvement of **27.3 (50%)** occurred in Group 1, **8.8 (24.6%)** in Group 2 and **19.3 (43.6%)** in Group 3 between the first and the fourth visits. Between the fourth and seventh visit, an improvement of **13.6 (49.8%)** for Group 1, **15.8 (58.7%)** for Group 2 and **13.8 (55.4%)** for Group 3 can be seen. Over the seven visits, an overall improvement of **40.9 (74.9%)** occurred in Group 1, **24.6 (68.9%)** in Group 2 and **32.3 (73%)** in Group 3. One can conclude that there was a significant decrease in the signs and symptoms of all the participants in all three groups.

Sino-Nasal Outcome Test: Inter-group analysis

The Kruskal-Wallis Test was performed for the analysis of the subjective data collected to determine if one treatment protocol was more beneficial than the other treatment protocols. The subjective data was collected from the Sino-Nasal Outcome Test scores, as shown in Figure 2.

The p-values for the subjective data, as discussed in Chapter four, were **0.14** for visit one, **0.97** for visit four and **0.44** for visit seven. The results for the subjective data was not significant and therefore one can conclude that no treatment protocol was more beneficial than the other.

Sino-Nasal Outcome Test: Intra-group analysis

To determine if there were any changes occurring within each group over time, the Friedman Test was performed. The results of the p-values were **0.00** for Group 1, **0.00** for Group 2 and **0.00** for Group 3. The results for this test were significant, which means that changes occurred within all three groups over a period of seven visits.

Owing to the significance of the Friedman Test, the Wilcoxon Signed Ranked Test was performed to determine between which set of visits the changes occurred. The results of the p-values for this test for Group 1 were **0.00** between visit one and visit four, **0.01** between visit four and visit seven and **0.00** between visit one and visit seven. The p-values for Group 2 were **0.01** between visit one and visit four, **0.00** between visit four and visit seven and visit one and visit seven. The p-values for Group 3 were **0.00** between visit one and visit four, visit four and visit seven and visit one and visit seven. It can be concluded that the results were significant, which means that changes occurred from visit one up to visit seven, without the exception of one group or a specific set of visits.

Objective Data Analysis

Pressure algometer readings

The objective data in this study was gathered by the pressure algometer as, shown in Figure 3. The pressure pain threshold of all three groups were compared over the first, fourth and seventh visits, and can be seen in Table 2. Between the first and fourth visits, a positive improvement occurred in the total pressure pain threshold of the frontal and maxillary sinuses: **1.96 (24.8%)** for Group 1, **0.86 (11.7%)** for Group 2 and **1.58 (19.7%)** for Group 3. A positive improvement also occurred between the fourth and seventh visits: **1.09 (12.15%)** for Group 1, **0.97 (11.65%)** for Group 2 and **1.06 (11.68%)** for Group 3. Over the seven visits an overall improvement of **3.05 (34%)** occurred in Group 1, **1.83 (21.9%)** in Group 2 and **2.64 (29.1%)** in Group 3. One can conclude that there was a significant increase in the total pressure pain threshold over the frontal and maxillary sinuses of all the participants in all three groups.

Pressure algometer readings: Inter-group analysis

The Kruskal-Wallis Test was performed for the analysis of the objective data collected to determine if one treatment protocol was more beneficial than the other treatment protocols. The objective data was collected from the pressure algometer readings.

The p-values for the objective data were **0.58** for visit one, **0.40** for visit four and **0.14** for visit seven. The results for the objective data were not significant and therefore one can conclude that no treatment protocol was more beneficial than the other.

Pressure algometer reading: Intra-group analysis

To determine if there were any changes occurring within each group over time, the Friedman Test was performed. The results of the p-values were **0.00** for Group 1, **0.00** for Group 2 and **0.00** for Group 3. The results for this test were significant, which means that changes occurred within all three groups over a period of seven visits.

Owing to the significance of the Friedman Test, the Wilcoxon Signed Ranked Test was performed to determine between which set of visits the changes occurred. The results of the p-values for this test for all three groups was **0.00** between visit one and visit four, visit four and visit seven and visit one and visit seven. It can be concluded that the results were significant, which means that changes occurred from visit one up to visit seven, without the exception of one group or a specific set of visits.

DISCUSSION

Discussion of Subjective and Objective Data

Taking both subjective and objective data analysis into consideration as discussed above, one can clearly see that there was no treatment protocol that was more beneficial than the other treatment protocols. One can also see that there were changes that occurred between each set of visits within all three groups, as shown in Figures 4 and 5.

We can assume that although the tests that were performed showed no overall difference among the treatment protocol, a more rapid response occurred in Group 1 and Group 3 between visit one and visit four compared to Group 2. This result might be because of the chiropractic manipulative therapy that was delivered to vertebral restrictions in the upper cervical spine, as explained by Bogduk (2001). Bogduk found that when these restrictions are corrected by spinal manipulative therapy, thus reducing compression and irritation of the nerve roots, there is a relief of symptoms such as headache, sinus pain and tenderness caused by these restrictions.

Another reason for the rapid improvement seen in Group 3 might not only be owing to the correction of the restrictions in the cervical spine but also to the application of ultrasound therapy on the frontal and maxillary sinuses, causing a decrease in nasal obstruction and improving breathing (Rocha, 2011). Thus, improvement might have also occurred because ultrasound therapy not only increases blood flow to the frontal and maxillary sinuses but also has a pro-inflammatory response, which helps with pain relief and improved breathing (Speed, 2001).

However, improvement not only occurred in Group 1 and Group 3 but also in Group 2, as stated above, although Group 2 had only the same rate of improvement as Group 1 and Group 3 after the fourth visit. As indicated above, ultrasonic waves are generated by the vibration of crystals within the head of the ultrasound probe. The ultrasonic waves not only cause a vibration of the local soft tissue as they penetrates through the skin but also cause a deep heat in the local soft tissue (Miller, 2014). This deep heat both increases the blood flow, which affects the

metabolism of soft tissue cells, but also decreases pain and inflammation (Jacques, 2010). Improvement of participants that received ultrasound therapy might also occurred owing to the disruption of biofilms and nasal polys as discussed by Karosi (2013).

However, the slower rate of improvement than the other two protocols may be explained by reference to other studies. Young (2010) conducted a study on 18 participants using therapeutic ultrasound for the treatment of chronic sinusitis. He found an improvement of **34.1%** after six treatment sessions. In another study done on ultrasound therapy on chronic sinusitis, 40 participants showed an improvement of **43.9%** after ten treatment sessions (Ansari, 2012). One can thus see that when a participant receives more treatment sessions with therapeutic ultrasound, a higher percentage of improvement occurred. This need for more treatments may account for why Group 2 had a slower improvement rate between visit one and visit four compared to Group 1 and Group 3 and a more equal rate of improvement after the fourth visit.

We can finally conclude that the treatment protocols of Group 1 and Group 3 were more beneficial to the participants over the first four visits but over the seven visit period, none of the treatment protocols were more beneficial than the others.

CONCLUSION

This study was performed to determine the effect of ultrasound therapy and upper cervical manipulative therapy as well as the combination thereof on chronic sinusitis.

Intra-group analysis was performed for both subjective and objective data, which resulted in statistically significant values for all three groups. These results indicate that changes occurred over the seven consultation visits period with regards to a decrease in the signs and symptoms of the participants in all three groups, specifically sinus pain and tenderness.

Inter-group analysis was performed for both subjective and objective data and resulted in not being statistically significant. Although the inter-group analysis was found to not be significant, the subjective data had a positive average improvement of **40.9 (74.9 %)** for Group 1, **24.6 (68.9 %)** for Group 2 and **32.3 (73 %)** for Group 3. The objective data had a positive average improvement of **3.05 (34 %)** for Group 1, **1.83 (21.9 %)** for Group 2 and **2.62 (29.1 %)** for Group 3, and therefore was clinically significant.

This research thus proved that ultrasound therapy and upper cervical manipulative therapy as well as the combination thereof did benefit participants with chronic sinusitis. Participants had to receive all six treatments to experience a significant difference in their signs and symptoms.

This research further proved that no treatment protocol was more beneficial than another for the treatment of chronic sinusitis. Therefore, depending on practitioner's preference of a treatment protocol, all individuals will still benefit from the three treatments tested.

The benefit of this study was to indicate whether ultrasound therapy and upper cervical manipulative therapy as well as the combination thereof had proved to be beneficial in the treatment of chronic sinusitis. It also provide a platform for further studies in this field. This study provides more insight into chiropractic treatment of chronic sinusitis and affords the practitioner with a more beneficial management protocol.

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